SOLVING THE K-6 MATH CURRICULUM PROBLEM,

by

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In June 2014 the CD Howe Institute published a report on the continuing decline in Canadian math scores observed on the 2012 PISA exams. A second CD Howe report by A. Stokke identified the children of Newfoundland and Labrador (NL) as being at particular risk. To put things in context, the next paragraph is excerpted from the NL 2009 Kindergarten Guide, p. 7:

> "The Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics" released in 2006 by the National Council of Teachers in Mathematics (NCTM) and the Western and Northern Canadian Protocol (WNCP) Common Curriculum Frameworks for Mathematics K – 9 (WNCP, 2006), assists many provinces in developing a mathematics curriculum framework. Newfoundland and Labrador has used this curriculum framework to direct the development of this curriculum guide.

CD HOWE ISSUES

Stokke's analysis of the PISA and related results identified three areas of concern related to curriculum and pedagogy:

1. The K-8 math curricula used in Canada produced poor outcomes and this was particularly true for those provinces that have adopted the WNCP math curriculum.

2. The NCTM derived curricula used in Canada are structurally unsound.

3. The pedagogical practice known as "Discovery-Based Instruction" is ineffective when applied to novice learners such as children in K-6.

To the degree the criticisms raised in Stokke's report are accurate, they should be of great concern to every parent with a child in the school system because, like it or not, math skills are life skills, and lack of math skills will be an ever increasing handicap in today's evolving world. For this reason we examine Stokke's facts and arguments with care.

OUTCOMES

PISA testing is done on 15 year-olds and therefore it is arguable that the effect of the change to the new WNCP curriculum in 2009 would not be observed on 2012 tests of 15 year-olds. To know what that effect would be one would have to test in earlier grades which was not done in NL and possibly justifies a ministerial response of "Give the new curriculum a chance." However, another international test, TIMSS, does test children in Grade 8 and although NL did not participate in TIMSS testing, Alberta (AB) did, and AB has used the same WNCP curriculum as NL since 1995. So the AB results are likely to be predictive for what can be expected in NL.

A key result presented in Stokke's report was that AB students were unable to correctly identify an expression for (1/3-1/4) at a rate that was any better than guessing. The success of AB students on this question was almost 60 points lower than that of students in the best performing country. It is tempting to dismiss this with "So what, we live in an age of calculators." However, by making that dismissal we should understand that that act closes the door to all learning requiring any form of symbolic algebra and this list runs the gamut from science to business to many trades. So if your child's dreams include a career that requires post-secondary, knowledge of how to compute with numerical fractions is most likely an essential prerequisite.

CHANGING CURRICULUM CHANGES OUTCOMES

It has been argued by some that the choice of curriculum doesn't matter and that the reason our children perform poorly is because our teachers are not up to speed. If there is factual evidence to support this claim, it is not available in the public literature.

However, in a seminal analysis of the results of TIMSS testing in 1995, a research group at the Educational Policy Center (EPC) and Michigan State University found that ALL the high performing countries used essentially the same K-6 math curriculum. This curriculum was narrowly focused and coherent. Schmidt et al., the EPC research group, refer to such curricula as being A+ curricula. In contrast, they describe North American NCTM derived curricula as being a “mile wide and an inch deep” because they contain a plethora of topics that are endlessly repeated. So the evidence tells us that there is an effective K-6 math curriculum which produces good outcomes for almost all children. But according to common wisdom, the countries using the A+ type curricula are Asian and their kids spend “25 hours per day” doing math, so an A+ curriculum wouldn't be successful in North America.

In 1998 a version of the A+ curriculum was introduced into a limited subset of California school boards which included schools having a high percentage of economically disadvantaged and English learning immigrants, in other words, students who were very unlikely to meet the “25 hours per day” at math stereotype. Students in schools using the A+ curriculum were compared with students from schools using the standard California math curriculum derived from the 1989 NCTM standards. Performance of the economically disadvantaged students in A+ districts rose 32 points over a period of 5 years. In comparison, a total increase of only 7 points was observed over the same period for the students in NCTM control districts (see Hook, Bishop and Hook). The message is simple: an A+ curriculum can work here in NL and dramatically improve student outcomes.

STRUCTURE

The EPC group characterized typical North American K-8 math curricula as being a “mile wide and an inch deep.” To get a sense of what this means, consider that the math Kindergarten curriculum document for NL requires 161 pages, whereas the entire K-6 math document for Singapore in 2007 requires 40 pages. Ask yourselves: Just what are we teaching our children about math in Kindergarten that requires 161 pages?

A paper by Liping Ma provides a careful explanation of how NCTM math curricula went astray by ceasing to effectively teach arithmetic. Suffice it to say, children in A+ countries spend 80% of their time in K-6 learning the arithmetic that would enable them to run a hardware/lumber store. (The arithmetic knowledge required to run such a store is complete and prepares all students for later life, including the continued training necessary to get into post-secondary programs.) The remaining 20% of an A+ curriculum is filled with measurement, geometry, and a bit of algebra which does not start before Grade 3.

A complete discussion of structural issues is incompatible with space requirements here, but Ma's paper can be understood by anyone who has completed high school. The essential point is we have known since at least 2007 that an A+ math curriculum will get the job done for NL's children. So why wasn't an A+ curriculum adopted by our experts?

PEDAGOGY

The most effective curriculum in the world can be defeated by poor teaching practice. A teaching methodology that demands that our children develop for themselves the ideas and/or methods that it took our ancestors thousands of years to develop is such a practice. Discovery Learning, which underlies the WNCP curricula has been criticized previously in The Telegram. The most direct analysis of why unguided instruction does not work for novice learners is contained in a paper by Kirschner, Sweller and Clark, three eminent cognitive scientists. A central point of their paper is that discovery learning is in conflict with what is known from neuroscience about learning. More importantly, study after study has shown the various forms of unguided instruction produce reduced outcomes in comparison to guided instruction. As a math teacher for more than 40 years I will simply say that the most effective instruction involves guiding students through well-chosen examples which students can then use as models in future problem solving. Guided instruction also is superior by every other measure as well, for example, self-esteem (see the Athabaska University website on Project Follow Through).

THE PROCEDURES of ARITHMETIC

Mathematics is essentially procedural; that is, there are a short list of procedures (standard algorithms) that enable anyone to solve problems. As stated on the Wisemath website, the WNCP curriculum replaces the standard procedures of arithmetic with a multiplicity of strategies which are arguably ineffective in comparison (see also p. 101 of NL Grade 4 Curriculum Guide). If our teachers are asked not to teach the time-tested algorithms to our children, then we certainly cannot expect them to learn these algorithms on their own (see Wisemath website on WNCP curriculum). In the final analysis, it is our children who are left to pay the price when they are denied access to programs in the future for lack of critical skills.

WHAT TO DO

There is an election coming. The only way this situation will change is if the politicians inform themselves of the facts and act on those facts. The only way the politicians will act is if we the voters demand that they do so. The only reason for voters to demand a change is because they have informed themselves which means reviewing the evidence presented and acting based on that review. Links to every document and every website discussed in this piece can be found on my website at Memorial University (http://www.math.mun.ca/~hsgaskill/). These documents are accessible to anyone with a high school education. If after reviewing the evidence you are convinced, take the case to your local candidate. Let's all understand one thing, this is not about politics; it's about our children and what they need to learn (and CAN learn) to achieve their dreams in the future.